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Learning Outcomes for a Business Information Systems Undergraduate Program

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Abstract:

We present a learning outcomes framework for an Information Systems (IS) undergraduate program. This framework includes a supporting software application that goes beyond any other attempt reported to date to integrate learning outcomes into program-wide and course-wide curriculum development, ongoing curriculum redesign, and student learning support. The Learning Outcomes Management System (LOMS) described here is a first-of-a-kind information system created as part of implementing a program-wide learning outcomes framework in a university setting. Our learning outcomes framework is distinct in that 1) it is based on a three-level hierarchically structured definition of learning outcomes that consistently apply to both the entire IS program as well as to each individual IS course; 2) customization for specific courses is easily done without requiring the drafting of new learning outcomes; 3) the dean's office and faculty use the learning outcomes framework to design, monitor, and revise both the entire IS curriculum as well as each individual course on an ongoing basis; 4) when students assess their own capabilities against our school's learning outcomes, it is done on a more global basis (versus a course specific basis), based on what students have done in their IS coursework, in their business, social science, and liberal arts coursework, as well as in their internships and extra-curricular activities; and 5) we incorporate the framework into a school-wide information system, LOMS, which has an application and supporting interface customized for faculty's needs, students' needs, and employers' needs.

Keywords: learning outcomes, learning outcomes management system, Information Systems curriculum design, business IT curriculum design

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I. INTRODUCTION

This paper presents the result of six-year effort to develop and implement a learning outcomes framework for the Bachelor of Science (Information Systems Management) degree program offered by the School of Information Systems (SIS) at Singapore Management University (SMU). The framework also includes the development and implementation of a supporting Learning Outcomes Management System (LOMS) which enables faculty to integrate learning outcomes into both course-level and program-level curriculum design and into ongoing redesign and improvement. LOMS enables students to assess their capabilities against the school's learning outcomes framework throughout the duration of their undergraduate studies. Finally, LOMS provides a structured way for students to communicate with potential employers about their skills and skill-building experiences, serving as a complement to the information provided in their resumes.

This paper begins in Section II with a review of the literature of learning outcomes in educational curriculum design and assessment. It follows in Section III with an account of how we initially developed high-level learning outcomes to provide guidance for the development of a brand new, green-field BSc (Information Systems Management) degree program launched in August 2003. In Section IV, a description of the school's IS management undergraduate curriculum is presented to provide context for understanding the learning outcomes framework. The initial three years' experience of integrating learning outcomes into our curriculum design is summarized in Section V. The reasons for why the initial set of learning outcomes had to be redesigned and the results of the redesign are given in Section VI.

The remainder of the paper, Section VII, explains how the revised learning outcomes framework led to the creation of a first-of-a-kind Learning Outcomes Management System (LOMS) developed and implemented at SIS to enable faculty and students to integrate learning outcomes into the process of teaching and learning. Within this section, we explain the rationale, functionality, and usage of the faculty interface, student interface, student self-assessment report, student progress report, and features for sharing these student reports with potential employers. Finally, the conclusion in Section VIII summarizes how our learning outcomes framework and LOMS benefit the school, faculty, students, and employers. Also an update is provided on implementation efforts.

II. LEARNING OUTCOMES IN EDUCATIONAL CURRICULUM DESIGN AND ASSESSMENT

The term "learning outcomes" has been used in educational settings to refer to the competencies the student is supposed to develop, as well as the assessment process that provides evidence of improvement in competencies, capabilities, or knowledge as a result of education [Filipp 2001]. Osters clarifies that learning outcomes describe what students are able to demonstrate in terms of knowledge, skills, and values upon completion of a course, a span or several courses, or a program [Osters 2003]. She also notes that clear articulation of learning outcomes serves as the foundation to evaluating the effectiveness of the teaching and learning process.

Learning outcomes have been used in pre-college vocational or occupational curriculum design for decades. For example, Dunster presented learning outcomes for a vocationally-oriented secondary school business curriculum [Dunster et al. 1977]. At the tertiary level of undergraduate education, two-year community colleges have a longer history than four-year programs of systematically developing and assessing learning outcomes. For example, Heiland and Switzer-Kemper report on a seven-year learning outcomes project at the institutional level of a community college that resulted in "noticeable and documented improvements in the quality of student learning [Heiland and Switzer-Kemper 2007]. Other community colleges have reported the establishment of presidential level study groups on student learning outcomes for degree and certification competencies [Lehigh County Community Coll. 1992]. Filipp notes that most four-year colleges and universities initially began using learning outcome assessments to improve programs in occupational disciplines such as nursing and information technology [Filipp 2001].

In the mid-1990s, four-year colleges began reporting on the use of competency-based learning outcomes to design and assess more general educational programs such as liberal arts [Mirel 1995]. In 1996, the state of Maryland in the United States initiated a state-wide effort to plan for how to assess undergraduate student learning outcomes at all of its publicly sponsored tertiary educational institutions, including two-year community colleges, four-year undergraduate colleges, and universities. Implementation started in 1998, and the first student learning outcomes assessment reports were submitted to the Maryland Commission on Higher Education in 2001 [Filipp 2004]. Filipp noted that most of Maryland's public community colleges had begun developing formal learning outcomes assessment systems prior to or by the year 2000. In contrast, most of Maryland's four-year colleges and universities started a learning outcomes effort after the year 2000. By 2004, learning outcomes assessment was taking place at the course-level at all of the state's four-year institutions [Philip 2004].

More recently, the specification and assessment of learning outcomes have become a central focus in undergraduate and postgraduate business education. In 2003, the Association to Advance Collegiate Schools of Business (AACSB) changed its accreditation standards to emphasize "direct assessments of student learning through the formulation of specific learning goals and the conduct of direct assessments of learning goal attainment" [AACSB International Accreditation Coordinating Committee 2007]. The term "learning goal" used in the AACSB accreditation standard is defined as "the description of desired educational accomplishments for graduates of each degree program" [AACSB International Web site 2008]. The AACSB Assurance of Learning Standards Interpretation document clearly asserts these learning goals are for outcomes assessment. The intent and meaning of learning goals, as used by AACSB, is the same intent and meaning of learning outcomes as described in the literature cited above.

Studies related to the use or assessment of learning outcomes specifically in Information Systems (IS) tertiary education have been appearing since 2003. [Jarmoszko et al. 2003] reports on an initial pilot effort at Central Connecticut State University to assess student learning outcomes for a single senior year course on systems analysis and design, and noted efforts underway to do similar assessments for additional courses. [Andrews 2004] reports on an effort at the Australian Defense Force Academy, where learning outcomes are used to do a major redesign of an entire IS curriculum program. They initiated the redesign by identifying the attributes of junior IS professional in the workplace, broke these attributes into competencies to be covered by courses and identified levels of expected performance across each year of undergraduate study. They then mapped the competencies against the steps of a system development life cycle to create an IS curriculum framework, and mapped learning outcomes and content against the framework to create a final curriculum.

Abraham [2004] reports on an effort at Siena Heights University that used learning outcomes at both the IS program-level and at the individual IS course-level to provide a means of measuring and assessing student learning in their courses. Faculty agreed on six measurable outcomes at the IS program-level. They created a summary matrix indicating which of the program-level learning outcomes were covered in each individual course. Faculty then identified an additional five to six unique learning outcomes for each specific course that were consistent with the program-level outcomes covered by that course. The article provides details on how they assessed student learning in one particular IS course.

The IS 2002 Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems [Gorgone et al. 2002] is the most recent update of an ongoing effort by ACM, AIS and other key international IS professional bodies to define and improve IS undergraduate curriculum. The model curriculum is to help universities produce IS students equipped to function in entry level information systems positions who also have strong basis for continued career growth. Since this model curriculum document plays such an important role in the undergraduate IS education community, we re-examined it from the perspective of whether it explicitly incorporates learning outcomes.

The model curriculum is defined in hierarchical terms, starting with five curriculum presentation areas. There are 10 core courses plus additional prerequisite courses across these presentation areas. Each course consists of learning units, with each learning unit describing a set of IS related material to be learned by students.

Are these learning units the same as learning outcomes? Not really. The intent is different. As noted earlier, the purpose of a learning unit is to describe a set of materials to be learned in a course (e.g. "show how information technology can be used to design, facilitate, and communicate organizational goals and objectives") whereas a learning outcome is crafted to describe what students should be able to demonstrate and should describe observable student behaviors that can be assessed.

The IS 2002 Model IS undergraduate curriculum [Gorgone et al. 2002] also identifies "exit characteristics" for a student completing an IS bachelors program and starting work as an entry level IS professional. These exit criteria are the representative capabilities and knowledge expected of IS program graduates. Some of the exit characteristics are specified as broad areas (e.g. accounting, computer systems hardware) versus demonstrable skills and therefore are not learning outcomes. Other exit criteria are specified in terms of what students should be able to demonstrate (e.g. design and development of multi-tier architectures, development of a Web page) and could serve as learning outcomes. The exit characteristics of an IS bachelors program graduate listed in the IS 2002 model curriculum document are similar in spirit to learning outcomes in that they describe the capabilities and knowledge an IS bachelors graduate should have. However, the exit criteria were not written with the specific intent of serving as measurable learning outcomes as defined previously by Osters and others that would be used for student learning assessment.

III. OUR INITIAL LEARNING OUTCOMES

The initial version of learning outcomes for the SIS bachelors program was drafted in April 2003, prior the intake of the pioneer freshman class. Learning outcomes became a strategic focus of the School's undergraduate educational program based on the suggestion of the co-author Goodman, who was serving as an advisor to SIS. Goodman had been studying new learning models and educational innovations in university settings. Through his field studies, he had come to realize both the importance and the relative infrequent use of explicit learning outcomes in the design and evaluation of new programs in university educational settings [Goodman 2003; Goodman and Beenen Forthcoming]. Since SIS was designing a new Information Systems program from a clean slate, with no legacy-related restrictions, Goodman emphasized that it was an especially opportune time to trial the creation and usage of learning outcomes for the entire program. The remainder of this section reviews the development of our learning outcomes for the new IS Bachelors program.

At the very outset of the curriculum design in January 2003, the program designers considered how to specify a student's core competencies or skills that would provide him or her with a sound foundation for entering the future workplace as a business-oriented Information Systems professional. Employment preparation was the primary motivation in the design of both the learning outcomes and the Bachelor's degree program. An additional consideration was that the outcomes as well as the program also had to provide the academic foundation for the option of future graduate studies at some later point in time.

Since SIS was a brand new school, and part of a young university only three years old at that time, the IS Bachelor's degree program design team aspired to create a set of distinctive learning outcomes compared to what other universities locally, regionally, and internationally were doing in the area of business-oriented Information Systems. In addition, this set of learning outcomes needed to be perceived as relevant and progressive by people in industry who would later be asked to hire these students for internships and subsequent full-time employment.

The crafting of the initial SIS learning outcomes were based on a review of six different information technology-related degree programs at Carnegie Mellon University, consultations with faculty involved in these programs, ongoing consultations with industry practitioners and senior executives in Singapore, Goodman's studies of educational innovations in university settings, and on co-author Miller's industry experience in the prior 13 years as an information systems user, designer, and systems integration consultant. The design team concluded that the learning outcomes should highlight (1) innovative usage of information systems to improve business processes and services; (2) a strong technical base in information systems principles, technologies, and practices; and (3) innovative learning and project experiences in local, regional and global settings. After approximately six months of discussion and draft iteration between the SIS Bachelor's degree program designers in Singapore and an advisory team of four faculty members from Carnegie Mellon University, an initial set of seven high-level learning outcomes was agreed upon. These are shown in Table 1.

Table 1. SIS' Initial Set of High-Level Learning Outcomes (July 2003)

1	Integration of business and technology analysis skills in a sector context
2	IT architecture, design and development skills
3	Project management skills
4	Learning to learn skills
5	Collaboration (or team) skills
6	Change management skills for enterprise systems
7	Skills for working across countries, cultures and borders

The initial SIS learning outcomes were derived independently of the information on exit characteristics of students completing IS undergraduate programs given in [Gorgone et al. 2002]. Yet our seven high-level SIS learning outcomes are highly overlapping with the five high-level exit characteristics given in the IS 2002 undergraduate curriculum model (see Section IV).

Defining learning outcomes is an essential pre-requisite for building effective learning environments, but it is only the initial phase of the effort. Implementing the learning outcomes is another matter altogether. Implementation includes the effort of refining the definitions to make them operational, getting buy-in from all faculty, students and employers, and making learning outcomes an accepted and integral part of curriculum design and delivery. Effective implementation, of course, is necessary in order for learning outcomes to have the intended effect.

In the remainder of the paper, we report on our six-year effort to implement a learning outcomes framework and culture within the workings of the SMU School of Information Systems. We proceed with a brief description of the undergraduate program structure and content to provide a context for understanding our learning outcomes framework.

IV. IS MANAGEMENT UNDERGRADUATE CURRICULUM

SIS uses two separate visual representations to convey the macro structure of its undergraduate degree program. Figure 1 shows the three foundation pillars upon which the entire school is conceived and built, not just the undergraduate program.

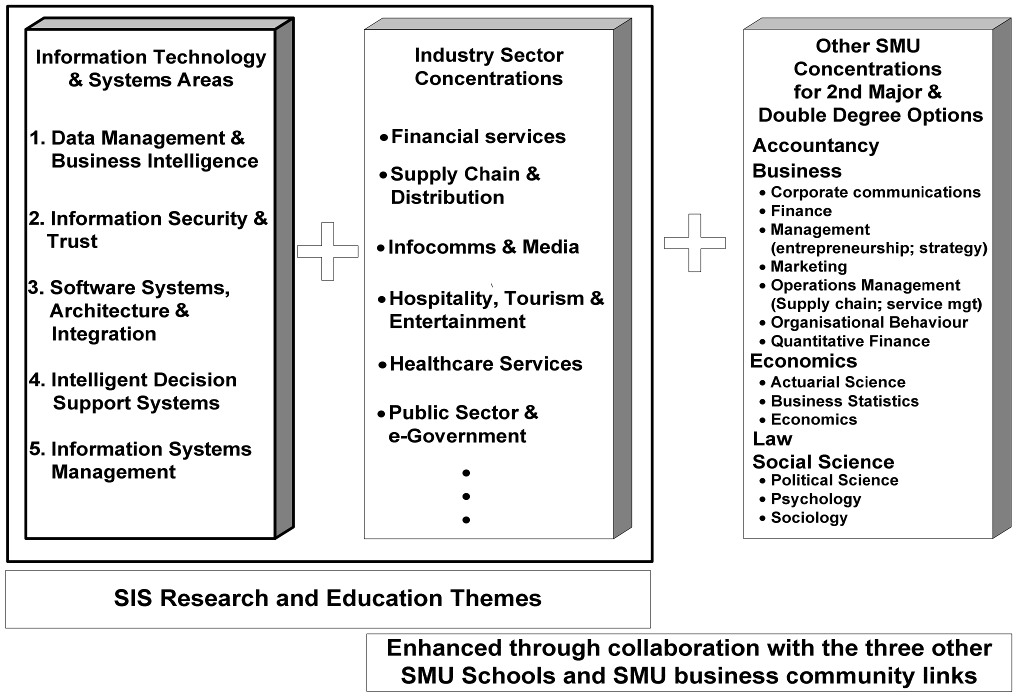


Figure 1. Three Foundation Pillars

The first column, labeled *Information Technology and Systems*, represents the premise that the school will have deep technology capability in the first four areas listed, as well as deep capability in the fifth area, IS management. The second column, labeled *Industry Sector Concentrations*, represents the premise that to the fullest extent possible, SIS will explore the creation, use, and management of information technology and systems in the context of specific industry sectors and their related real-world business processes. The third column represents all of the other areas of study available at SMU outside of Information Systems. It represents the premise that both our students and our faculty need to engage with one or more of these other disciplinary areas in order to fully leverage the potential of the university as well as to understand the business and management aspects related to information technology and systems usage. As a matter of practice, more than 85 percent of our undergraduate students do second major concentrations or double degrees in one of the non-IS areas shown in the third column, or in specialization tracks at the intersection of the first two columns (e.g. business intelligence & analytics, banking processes and solutions).

A second macro view of the SIS Bachelors degree program, shown in Figure 2, visualizes the degree program structure in terms of the number and types of courses required.

The first column shows the major groupings for the 14 core IS undergraduate courses delivered by SIS that all BSc (IS Management) students must take. The top of the second column indicates that students must take a minimum of six business or social science-oriented courses to complete the degree. The bottom of the second column indicates that we relentlessly encourage our students to take more than the minimum number of courses required to graduate, and to construct a customized “IT Plus” program for themselves by taking additional courses to meet the requirements for a second major concentration. The third column represents distributional requirements taken by all SMU students that support the formation of analytical and critical thinking, and the “soft skills” related to communications, interpersonal relations and team participation and management in a way that is not narrowly driven by specific job or professional needs. The names of the 14 required IS core courses delivered within SIS, corresponding to the first column of Figure 2, are shown below (Figure 3).

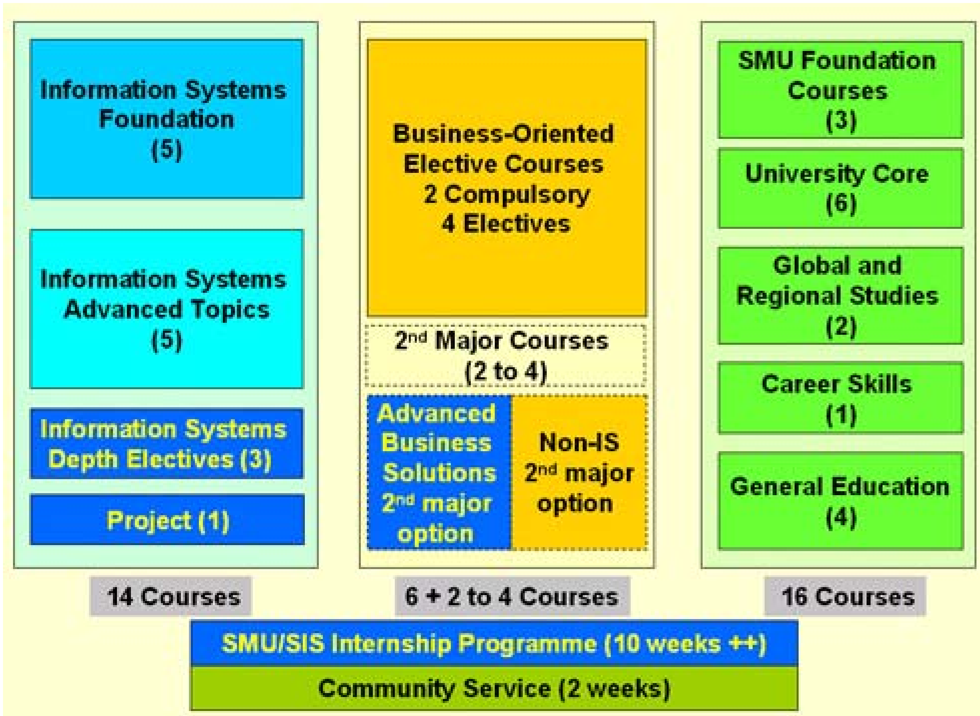


Figure 2. BSc (ISM) Curriculum Structure

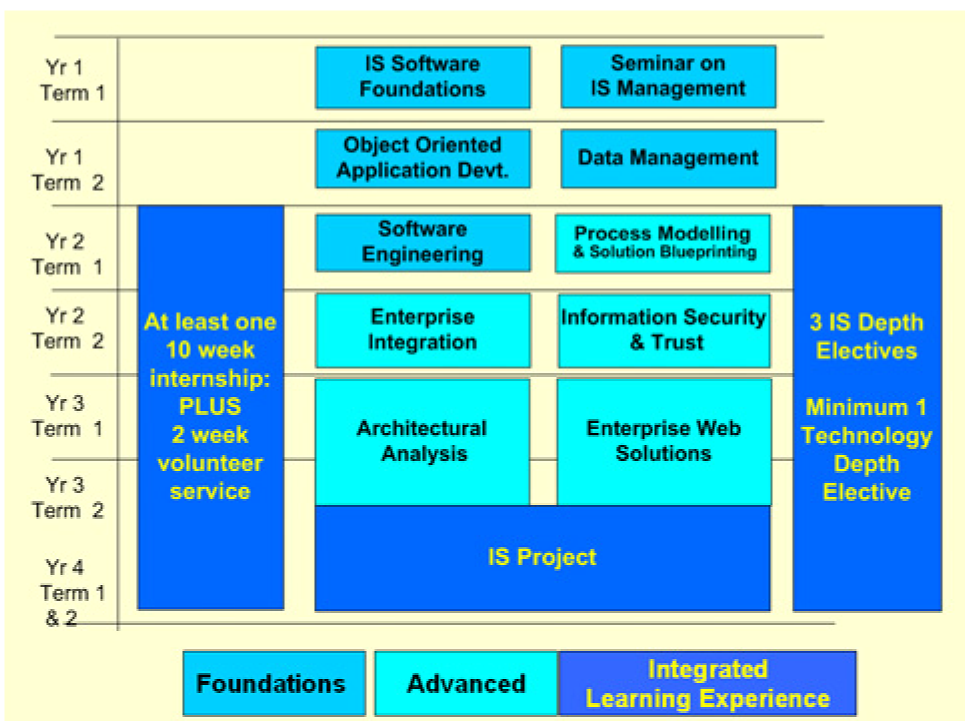


Figure 3. Courses Offered by SIS for the BSc (ISM) Degree

The program provides students with numerous in-depth experiences in defining, analyzing, designing, deploying, and using software-based business solutions. Over the 14 core IS courses, students gain considerable experience in managing team projects, and in using information technology and IS management concepts, together with business concepts and principles, to solve contextualized problems in complex business process settings.

All SIS undergraduate students are required to do at least one internship in either private sector or public sector organizations where they work on information technology or systems problems in the context of “real-world” work organizations. Nearly half of the IS students do more than one internship. These internship experiences are highly effective in getting students to understand the link between information technology and systems (the first column of Figure 1) and sector-specific business processes and industry dynamics (the second column of Figure 1).

The IS 2002 undergraduate model curriculum [Gorgone et al. 2002] is centered around “guiding assumptions about the information systems professional” that lead to four major areas that “must be integrated into any IS curriculum,” as well as an implied fifth area which lies at the intersection of these four areas. The model curriculum adopts these five areas as the “high-level categorization of IS graduate exit characteristics,” the capabilities a program graduate needs to effectively function when starting a career in an entry-level IS position. The illustration of these five areas forming the exit characteristics, reprinted from the IS 2002 model undergraduate curriculum, is shown in Appendix 3, Figure 10.

The SIS Bachelor in IS management covers all five of the areas emphasized in the IS 2002 Model Undergraduate Curriculum. The 14 courses shown in Figure 3 provide the capabilities related to IT-enabled business solutions design, development, and deployment. These courses also emphasize design thinking, analytical and critical thinking in the IS context, as well as communications, team, and interpersonal skills within the context of defining, designing, and executing IS projects. The courses in the second and third columns of Figure 2 develop student capabilities related to business, organizational, and social science fundamentals. These courses also develop analytic and critical thinking skills as well as communication, team, and interpersonal skills outside the specific context of IS related problem solving. The required IS internship, along with the capstone IS application project, reinforce all five IS 2002 Model Curriculum areas shown in Appendix 3, Figure 10, and also help our students to realize the importance of the interconnections across all of these capabilities as well.

V. INTEGRATING LEARNING OUTCOMES INTO CURRICULUM DESIGN

In 2003, during the first year of the school’s operations, we developed a simple matrix mapping these initial seven high-level learning outcomes onto each of the individual IS courses that would be delivered within the School (Table 2). This matrix is similar to the one shown in [Abraham 2006, pg 5] except that our Table 2 matrix also maps the high-level learning outcomes against courses included in the bachelors curriculum but outside of the core IS course (the courses for the business-oriented second major option). We also include the integrated learning experiences, internships, project courses, and out-of-class (e.g. extra-curricular) projects in the matrix columns as well.

The list of high-level learning outcomes and the matrix mapping of outcomes against courses in Tables 1 and Table 2 were useful in communicating to the faculty who joined the school in its early start-up years what should be emphasized in each of the courses. These tables were also useful in communicating the distinctive aspects of the program to prospective students applying for places in the first three freshman intakes.

During the first three years of delivering the Bachelor’s program, all SIS faculty members inserted a learning outcomes summary table into their course syllabus document indicating which outcomes were strongly emphasized or addressed in the course. Within these initial years, we expanded the learning outcomes summary table in each course syllabus to include supporting information on how the outcomes were incorporated into the course content or assignments. This information was reviewed by the SIS dean and faculty during the curriculum review which occurred after every semester.

VI. REDESIGNING THE LEARNING OUTCOMES

The incorporation of a learning outcomes summary table into every course syllabus proved to be a good way for getting faculty to reflect on and use the learning outcomes concept while they were designing or redesigning their courses. It also seemed to be a good way to reinforce to students both the existence and importance of the school’s learning outcomes.

As part of an independent research study on learning environments in newly established universities [Goodman 2007], a sample of 32 our students were interviewed about the school’s learning environment. The data revealed that a relatively small percentage of the students could recall the school's learning outcomes. For example, only 9 percent recalled at least three outcomes, while 34 percent did not mention any. In a separate study of another new tertiary institution [Goodman and Beenen, Forthcoming], there were similar findings. That is, approximately 20 percent of the students did not remember any of that school’s learning outcomes, and only 24 percent remembered between six and eight of them.

In both new institutions there were a variety of processes (e.g. recruiting, Web site, course syllabus, speeches by administrators) to make the learning outcomes visible. The fact that few students knew most or all of the learning outcomes, and some students remembered none, indicates the scope of the challenge that any university faces in building learning outcomes into the life of the institution. At the same time, our ongoing implementation effort, as well as that of the other new tertiary institution studied by Goodman, demonstrates that real progress is achievable, though it requires a major sustained organizational commitment.

Table 2. Initial Summary Table of Learning Outcomes and Courses

	Y: The course contributes to builging the skill. **D**: Students should seek opportunities to build this "desired" skill.	**Business Oriented Courses**			**Foundation Courses**					**Advanced Topic Courses**			**Integrated Learning Experiences**			
		SMU 2nd major, double degree	**CAT (business modelling)**	**Seminar on IS Management**	**IS Design Foundations**	**Object Oriented Application Development**	**Data Management**	**Software Engineering**	**Networking**	**Enterprise Systems & Integration**	**Information Security & Trust**	**Architectural Analysis**	**Required Project Courses**	**Electives**	**Internships**	**Additional Out-of-Class Project**
1	**IT architecture, design and development skills**				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	D	D
2	**Integration of business & technology analysis skills in sector context**	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	D	D
3	**Project management skills**	Y		Y				Y		Y	Y	Y	Y		D	D
4	**Learning-to-learn skills**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	D	D
5	**Collaboration skills**	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		D	D
6	**Change management skills for enterprise systems**	D				Y		Y		Y		Y	D	D	D	D
7	**Skills for working across countries, cultures and borders**	D											D	D	D	D

Goodman's empirical feedback, showing that a majority of our students were not internalizing the learning outcomes constructs as thoroughly as we assumed they were, motivated us to concentrate on a second wave of implementation effort. When investigating what was impeding the effective transfer of the learning outcomes framework to all students, faculty, and teaching staff made us aware of the issues associated with the specification of the initial set of seven stated learning outcomes (Table 1). Specific definitions of each outcome had never been precisely stated and documented. It became evident that our faculty members had different interpretations of what was meant by each outcome, and some faculty were not sure whether or how a particular learning outcome applied to their course. This lack of clarity was one reason why some faculty did not always emphasize learning outcomes to students in their courses, though they were using them when conceptualizing the design of the course, and including them in the course syllabus.

Looking back, this lack of clarity associated with the initial set of learning outcomes in Table 1 is not surprising. In Osters' summary on how to write measurable learning outcomes, she emphasizes that outcomes should focus on students' observable behavior and on what students are able to demonstrate [Osters 2003]. She recommends that outcomes should be written using simple, specific action verbs. Note that our initial definition of learning outcomes shown in Table 1 are all stated using nouns that describe more general topic areas. At the outset of the design process, we needed more macro concepts to guide our thinking on the macro structure of the curriculum. It was too hard for us to start off with more precise and executable definitions of learning outcomes. It seemed more useful and natural to us at that point in time to state the desired outcomes in terms of nouns which described broader level concepts. While we were aware from the outset that we needed more precise definitions which could be implemented at a more micro level, we "satisficed" by using more general definitions shown in Table 1 that seemed understandable and good enough to carry us through an initial round of development.

By our third year of operation, we felt we had accumulated enough experience with operating the new program to know how to practically refine and redesign the learning outcomes. The dean (co-author Miller) was also compelled to address the gap between the school's stance that learning outcomes were an integral part of the SIS learning environment, and the fact that only a minority of students were making reference to learning outcomes when asked to describe distinctive features of SIS. Finally, we wanted better ways to gauge each student's learning progression with respect to these learning outcomes to obtain feedback on whether students were making progress in strengthening the competencies.

In 2005 and 2006, we initiated a major effort to refine our learning outcomes framework. The intent was to add a more detailed set of subskills to reduce or eliminate ambiguity as to 1) the meaning of each outcome; and 2) how a course contributes to the high-level learning outcomes. In this elaboration of subskills, we were guided by the following principles. The first principle was to restrict ourselves to a small number of essential subskills for each outcome. The second principle was to ensure that the subskills were demonstrable, observable, and measurable, in line with Osters' recommendation [Osters 2003]. The third principle was to make sure that the subskills were simply stated, unambiguous, and easily understandable by all (faculty, students, and employers). To give an example, "IT architecture, design and development skill," a high-level outcome described as a topic area, can be broken down in terms of observable and therefore measurable subskills that a student can demonstrate such as the ability to "elicit and understand functional requirements from a customer," or the ability to "identify nonfunctional requirements."

The process of further refinement proceeded by individually interviewing faculty responsible for teaching the IS courses to gather feedback on their use of the outcomes and their views on the important subskills associated with each high-level outcome. These interviews also help to educate our faculty about the outcomes, since our faculty size had substantially increased since the school's inception. We transferred the faculty's responses on subskills to index cards and used our subjective judgment to more precisely and consistently name the subskills, to eliminate duplication of similar subskills mentioned, and to cluster the concepts represented by each card under the relevant high-level (or Level 1) learning outcomes. This analysis resulted in the formation of two additional levels of subskills (Level 2 and Level 3) and the creation of an additional high-level learning outcome, communication skills.

Why were three levels of definition required? For each Level 1 outcome, we clarified that we were actually referring to a group of subconcepts (still high level). Each of these subconcepts became the Level 2 definitions. Even the Level 2 definitions were stated using nouns to describe topics, rather than in terms of verbs describing knowledge and skills that students could demonstrate and faculty could observe and assess. Yet, because we were still operating at a macro design level, we still found it more natural and easier to think in terms of descriptive nouns as a means of delineating the Level 2 definitions. Hence, there was still a need for an additional level. At the more macro Level 3, we stated the definitions in terms of specific abilities, and used verbs to describe things that people can do, making the definitions at this level demonstrable, observable and assessable.

Without the Level 1 definitions, it would not be possible to state the learning outcomes in terms of a small number of broad items (e.g. 10 or fewer) for an entire curriculum program. Hence, the high-level definitions are needed as the "index." Without the Level 2 definitions, the concept space for each of the Level 1 outcomes is too broad, since several subconcepts are included. People cannot easily agree on which aspect of the Level 1 outcomes they are talking about since there are no explicit, common definitions of the sub-concepts. Without the Level 3 definitions, the outcomes would not meet the requirements of a well-specified learning outcome as defined by Osters where she recommends using simple, specific action verbs to describe observable behavior reflecting what students are able to demonstrate [Osters 2003]. Appendix 1 shows the redesigned set of eight learning outcomes using the three levels.
The next section describes how the revised learning outcomes framework was used to create a Learning Outcomes Management System (LOMS) for our faculty, students, and industry employers.

VII. LEARNING OUTCOMES MANAGEMENT SYSTEM (LOMS)

The major motivations for LOMS were:

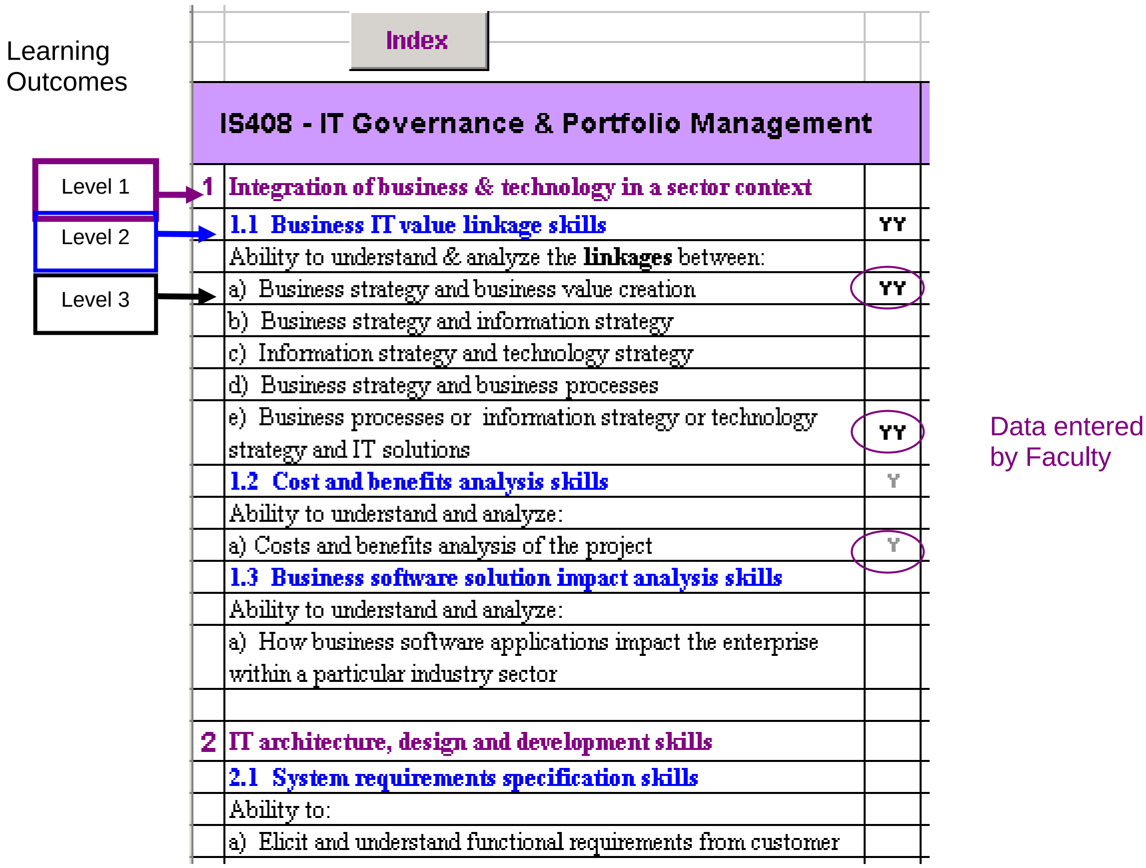
1. To support faculty in aligning their course design with the school's learning outcomes, and to incorporate a table on "Learning Outcomes, Achievement Tasks, and Assessment" into their course syllabus document.
2. To provide the school with a more systematic view of all of our IS required and elective courses in terms of learning outcomes coverage.
3. To give all our IS students a direct way to engage with the learning outcomes framework beyond just seeing the summary table in the course syllabus.
4. To give each student a way to reflect on the level of his or her own capability with respect to each learning outcome by going through a periodic self-assessment.

Our LOMS consists of two parts: a system that supports a faculty interface and another system that supports a student interface. The following subsections explain what these interfaces consist of, and what functionality and utility they offer for the school, faculty, students, and employers.

LOMS Faculty Interface

The faculty interface is currently implemented as an Excel-based application accessible by all SIS faculty and teaching staff. From the application's home page, SIS faculty select the tab for their own course, and are directed to the learning outcomes page for their particular course, as shown in Table 3. Faculty see the detailed list of learning outcomes and subskills (Levels 1, 2 and 3) and indicate which of the Level 3 subskills are the student learning outcomes for that course. A double "Yes" indication (YY) is given if the subskill is strongly emphasized and practiced in the course. Only a single "Yes" indication (Y) is given if the topic is covered, though not as strongly emphasized or practiced. In practice, faculty iterate between prescriptive and descriptive indications, going back and forth between their course syllabus document which specifies what they are actually going to do in the course and the learning outcomes table which specifies what types of skills the students are expected to demonstrate when they take the course.

Table 3. Sample of the LOMS Faculty Interface Used to Designate Course Specific Learning Outcomes



	IS408 - IT Governance & Portfolio Management	
1	Integration of business & technology in a sector context	
	1.1 Business IT value linkage skills	YY
	Ability to understand & analyze the **linkages** between:	
	a) Business strategy and business value creation	YY
	b) Business strategy and information strategy	
	c) Information strategy and technology strategy	
	d) Business strategy and business processes	
	e) Business processes or information strategy or technology strategy and IT solutions	YY
	1.2 Cost and benefits analysis skills	Y
	Ability to understand and analyze:	
	a) Costs and benefits analysis of the project	Y
	1.3 Business software solution impact analysis skills	
	Ability to understand and analyze:	
	a) How business software applications impact the enterprise within a particular industry sector	
2	IT architecture, design and development skills	
	2.1 System requirements specification skills	
	Ability to:	
	a) Elicit and understand functional requirements from customer	

When designing the faculty interface, there was considerable debate on the granularity of information that a faculty member should be required to specify. A subskill could be covered in the course through discussion only, or by discussion and practice without formal, explicit assessment, or by discussion and practice followed by formal, explicit assessment. The faculty realized that only using indicators of (YY) or (Y) to designate whether or to what extent a particular subskill was covered in the course was lacking in precision in that it did not differentiate down to the granularity of coverage by discussion, practice, or formal, explicit assessment. Even so, the faculty argued it would be far too cumbersome to provide this micro level of granular information indicating the nature of how a skill was to be covered for each of the Level 3 subskills that applied to the course. Since the school encourages and often requires ongoing course content revision, the final design decision was to stay with the more general (YY) and (Y) indicators for the Level 3 subskills. In order to capture more specific information on how skills are to be demonstrated and assessed within each individual course, the course-specific learning outcomes summary table was expanded by two additional columns for faculty to briefly use text to indicate the student tasks used to achieve the outcomes as well as the faculty methods to assess the outcomes. In response to faculty pleas to keep the time required to prepare the course specific learning outcomes information from being too excessive, this additional information on student tasks and faculty assessment methods is only provided at the Level 2 aggregation of the outcomes (see Table 4).

Table 4. Collapsed View of Course Learning Outcomes from LOMS

	IS101 - Seminars for ISM Majors		Student Tasks to Achieve Outcomes	Faculty Methods to Assess Outcomes
1	Integration of business & technology in a sector context			
	1.1 Business IT value linkage skills	YY		
	1.2 Cost & benefits analysis skills	Y		
	1.3 Business software solution impact analysis skills	Y		
2	IT architecture, design and development skills			
	2.1 System requirements specification skills	Y		
	2.2 Software and IT architecture analysis and design skills			
	2.3 Implementation skills			
	2.4 Technology application skills			
3	Project management skills			
	3.1 Scope management skills	Y		
	3.2 Risks management skills			
	3.3 Project integration and time management skills	Y		
	3.4 Configuration management skills			
	3.5 Quality management skills			
4	Learning to learn skills			
	4.1 Search skills	YY		
	4.2 Skills for developing a methodology for learning	YY		
5	Collaboration (or team) skills:			
	5.1 Skills to improve the effectiveness of group processes and work products	YY		
6	Change management skills for enterprise systems			
	6.1 Skills to diagnose business changes	YY		
	6.2 Skills to implement and sustain business changes			
7	Skills for working across countries, cultures and borders			
	7.1 Cross-national awareness skills			
	7.2 Business across countries facilitation skills			
8	Communication skills			
	8.1 Presentation skills	YY		
	8.2 Writing skills	YY		

Y This subskill is covered partially by the course

YY This subskill is a main focus for this course

As each faculty member creates or updates the indicators for the Level 3 subskills for their course, the LOMS faculty interface automatically generates a program-wide summary matrix which provides the school and faculty with a global view of the learning outcomes coverage across all required and electives IS courses (Table 5). This matrix contains the detailed Level 3 learning outcomes on the vertical dimension, and all the SIS courses in the BSc (ISM) program on the horizontal dimension.

Table 5. Sample Matrix Of Detailed Learning Outcomes across All Courses

BSc (IS Management) courses

Index

	Master Matrix	IS101 ISM	OPIM102 CAT	OPIM323 Outsourcing	IS200 ISSF	IS201 OOAD	IS202 Mgt Data	IS203 SE	IS204 Networking	IS301 EI	IS302 Security	IS303 AA	IS304 PMSB
1	Integration of business & technology in a sector context												
	1.1 Business IT value linkage skills	YY	YY	YY			Y	Y	YY	YY	YY	YY	YY
	Ability to understand & analyze the **linkages** between:												
	a) Business strategy and business value creation	YY	Y	YY						Y			Y
	b) Business strategy and information strategy	YY		Y								Y	
	c) Information strategy and technology strategy	YY		YY			Y	Y	YY		YY	Y	
	d) Business strategy and business processes	YY	Y	YY									YY
	e) Business processes or information strategy or technology strategy and IT solutions		YY	Y					YY	YY		YY	YY
	1.2 Cost and benefits analysis skills	Y	YY	YY	Y			YY			Y	Y	
	Ability to understand and analyze:												
	a) Costs and benefits analysis of the project	Y	YY	YY	Y			YY			Y	Y	
	1.3 Business software solution impact analysis skills	Y		Y								Y	Y
	Ability to understand and analyze:												
	a) How business software applications impact the enterprise within a particular industry sector.	Y		Y								Y	Y
2	IT architecture, design and development skills												
	2.1 System requirements specification skills	Y	Y	YY		Y	Y	YY	YY	Y	YY	YY	YY

The horizontal dimension clearly shows the extent to which a subskill is re-enforced across the full set of IS required and elective courses. The vertical dimension shows the subskill coverage profile of the particular course in the context of the coverage profiles of the other courses.

Also, the application automatically extracts the indication of sub-skill coverage for a particular course and generates an aggregated Level 2 course-specific view of learning outcomes coverage. This aggregated Level 2 view of learning outcomes coverage is copied into the design document (our term used for course syllabus) for each IS course. The faculty member responsible for each course then fills in the supporting information on "Student Tasks to Achieve Outcomes" and "Faculty Methods to Assess Outcomes" in the designated columns (see Table 6). In upgrades to LOMS that are planned for 2008 and 2009, the faculty interface system (currently an excel spreadsheet) will become a more "faculty friendly" Web-based application, and the transfer of the course-specific learning outcomes summary table into the course syllabus document will be automated.

Table 6. Sample of Learning Outcomes Table Appearing in a Syllabus Document of a Particular IS Course

	IS304 - Process Modeling & Solution Blueprinting		Student Tasks to Achieve Outcomes	Faculty Methods to Assess Outcomes
1	**Integration of business & technology in a sector context**			
	1.1 Business IT value linkage skills	**YY**	• Analyze business domains and identify appropriate processes for the domain – Assignment 1. • Analyze the Gillette case study to understand how IT can provide value to the business – Class case study discussion. • Apply the business process engineering methodology to a real world process (e.g. procurement, warehousing, insurance claim etc.) - Assignment 3. • Analyze example As-is processes and identify issues. Propose To-be process to improve upon the As-is process through effective utilization of IT – class	Grade Assignment 1, 2, 3 and Class exercises

			exercises, case study analysis and presentation (assignment 2).	
	1.2 Cost and benefits analysis skills			
	1.3 Business software solution impact analysis skills			
2	**IT architecture, design and development skills**			
	2.1 System requirements specification skills	**YY**	• Apply the business process engineering methodology to derive IT solution requirements from business requirements – Class exercises (Travel Requisition case study), Assignment 3.	Grade Assignment 3 and Class exercises
	2.2 Software and IT architecture analysis and design skills	**YY**	• Apply the business process engineering methodology for developing a concept solution architecture for automating a business process - Class exercises (Travel Requisition case study), Assignment 3.	Grade Assignment 3 and Class exercises
	2.3 Implementation skills			
	2.4 Technology application skills	Y	• Select appropriate technology for developing the concept solution architecture for automating a business process - Class exercises (Travel Requisition case study), Assignment 3.	Grade Assignment 3 and Class exercises
3	**Project management skills**			
	3.1 Scope management skills			
	3.2 Risks management skills			
	3.3 Project integration and time management skills			
	3.4 Configuration management skills			
	3.5 Quality management skills			
4	**Learning to learn skills**			
	4.1 Search skills	**YY**	• Students are given problems where they will have to apply search skills to find more information to solve the problem, for example identifying processes in specific domains – Assignment 1 and 3	Grade Assignment 1 and 3
	4.2 Skills for developing a methodology for learning	Y	• Students must apply this skill when working on Assignments 1, 2 and 3.	Grade Assignment 1, 2 and 3
5	**Collaboration (or team) skills:**			
	5.1 Skills to improve the effectiveness of group processes and work products	Y	• Students must apply the skills when tackling the group assignments – Assignment 1, 2 and 3	Grade Assignment 1, 2 and 3
6	**Change management skills for enterprise systems**			
	6.1 Skills to diagnose business changes	**YY**	• Apply the business process engineering methodology for representing process, identifying issues and suggesting changes – Assignment 2 and 3.	Grade Assignment 2, 3 and Class exercises
	6.2 Skills to implement and sustain business changes	Y		
7	**Skills for working across countries, cultures and borders**			
	7.1 Cross-national awareness			

	skills			
	7.2 Business across countries facilitation skills			
8	Communication skills			
	8.1 Presentation skills	YY	• Students have to explain and justify the processes selected for the given domain – Assignment 1 • Students have to conduct the case study discussion in class – Assignment 2 • Students have to present the business process engineering project – Assignment 3	Grade Assignment 1, 2 and 3
	8.2 Writing skills	YY	• Students have to write a report which contains the issues with the As-is process, proposed To-be process along with dynamic analysis, and concept solution architecture – Assignment 3	Grade Assignment 3

This subskill is covered partially by the course

YY This subskill is a main focus for this course

The purpose for putting the learning outcomes table into each course syllabus document is two-fold. The first reason, as referred to earlier, is to provide faculty and teaching staff with an aid for designing or revising the course. Faculty need to think through how they will expose the students to these skills (e.g. through lectures, examples, debates, e-learning), how they will provide opportunities for students to practice these skills (e.g. through in-class exercises, labs, assignments) and how they will verify that students have acquired the skills (e.g. through grading assignments, reviewing projects, evaluating presentations, exams). The fact that the faculty are asked to ensure the consistency between the skills noted in the learning outcomes table and the rest of the content of the course design document helps to reinforce the use and importance of the learning outcomes.

The second reason is to facilitate communication with students as to the nature and content of the course. For example, by looking at the learning outcomes indicated for a particular course, a student can tell which aspects of IS technology skill development are emphasized, or whether a course has more of an IS technology orientation or more of an IS management orientation. If the learning outcomes table in the course design document indicates strong or partial coverage of skills such as software and IT architecture analysis and design (2.2) and implementation (2.3), the student is clear that the course will provide hands-on experience with software or applications. In contrast, if the learning outcomes table indicates no coverage of these two skills, and strong coverage of skills related to system requirements specification (2.1), and integration of business and technology in a sector context (1.1, 1.2 and 1.3), the student knows that the course is oriented toward IS management, both in its content and in its style of delivery.

Our learning outcomes framework, including the LOMS application, is distinct from any other effort to apply learning outcomes reported in the literature pertaining specifically to IS curricula, or pertaining more generally to any type of curriculum application. To highlight distinctions, we focus on comparisons with other learning outcomes efforts related to IS university level educational programs.

The Siena Heights University effort reported by Abraham, also includes a treatment of learning outcomes at both the IS program-level as well as individual course-level [Abraham 2004]. However, their program-level outcomes are the comparable levels of description as our Level 2 outcomes. While they only use six Level 2 outcomes, they do not have a comparable Level 1 aggregation which describes higher level topics. They do not have a consistent hierarchical scheme to view the same outcomes at multiple levels of detail. Also their Level 3 outcomes are customized for the content of each individual course. Each time a new course is created or an existing course is substantially revised, their equivalent Level 3 detailed outcomes need to be created or rewritten. In contrast, in our framework, the same Level 3 description of skills are used for all IS courses, and for those sub-skills which covered in a particular course, faculty add course specific comments on the student tasks and how they are assessed.

In the Australian Defense Academy effort, Andrews notes that they map their learning outcomes and content against their curriculum framework [Andrews 2004]. Their curriculum framework is interesting in that it incorporates explicit phases of the system development life cycle (SDLC) and indicates how a single general statement of competency for each phase of the SDLC should evolve over each year of study. However the paper does not include any description of the learning outcomes they refer to, and therefore is limited in the extent to which it can be used as a template for other schools to design a learning outcomes framework. In the Central Connecticut State University effort, Jarmoszko et al. define learning outcomes for one specific course only, and not for an entire IS program [Jarmoszko et al. 2003]. Also their comparable Level 3 detailed sub-skill statements are specific to a particular course.

Our learning outcomes framework is distinct in that:

1. It is based on a three-level hierarchically structured definition of learning outcomes that consistently apply to both the entire IS program as well as to each individual IS course. The coverage of outcomes for the entire program or for a particular course can be viewed in full detail at Level 3 or in aggregated form at Level 2.
2. Customization for existing or new courses is easily done by faculty adding comments on student tasks and faculty assessment methods to a learning outcomes table incorporated in the courses syllabus document, without requiring the drafting of new learning outcomes at any level, especially Level 3.
3. The dean's office and faculty can use the framework for ongoing curriculum expansion and improvement by monitoring and revising learning outcomes for each individual course, and this automatically provides a view of learning outcomes coverage across the entire IS curriculum.
4. When students assess their own capabilities against our school's learning outcomes, it is not done on a course specific basis. Neither is their self-assessment limited to just the School of Information Systems courses that are part of their BSc (IS Management) degree. Student self-assessments of capabilities with respect to the IS program's learning outcomes are done on a more global basis, based on what students have done in there IS coursework, in their business, social science and liberal arts coursework, and in their internships and extracurricular activities.
5. We incorporate the framework into an information system, LOMS, which has an application and supporting interface customized for faculty needs, as well as for student needs. Using the LOMS faculty interface, a summary matrix of learning outcomes coverage by course is automatically generated at both Level 2 and Level 3 when faculty input their specific information for their particular course. Using the LOMS student interface, students can see their skill development progress over time, create improvement plans and communicate their capabilities to potential employers.

The LOMS student interface is described in the next section.

The LOMS Student Interface

The LOMS student interface is a Web-based application accessible by all SIS students, enabling each student to update their skill levels and skill-building experiences throughout their undergraduate studies at SMU. This interface allows SIS students to manage and update their learning outcomes throughout their undergraduate studies at SMU. To help students achieve this, the LOMS student interface offers four features: a "Self-Assessment" feature, a "Progress Report" feature, a "Self-Development Plan" feature and a "Release to Employer" feature as show in Figure 4. These four features are explained in the following subsections.

Figure 4. SIS LOMS – Student Interface – Home Page

Self–Assessment Feature

SIS wants all of its undergraduate students to go beyond the standard exercise of planning the courses needed to graduate, and to think seriously about obtaining the skills listed in the learning outcomes, regardless of whether that skill building occurs inside or outside of formal coursework. Therefore SIS wants its students to assess themselves at the end of each term with respect to each of the learning outcomes.

The students are able to access LOMS from the university's student portal. The LOMS student interface has been designed to present the learning outcomes to students only at Levels 1 and 2 to manage the quantity of data input required for the self-assessment. The Level 3 learning outcomes are also shown to students, but as information only, to aid them in remembering the more detailed Level 3 definitions when they do the assessment at Level 2. For each of the Level 2 learning outcomes (Table 4), students are asked to assess themselves according to a five-point Likert scale of *underdeveloped, slightly developed, somewhat developed, developed* and *very developed*. A description of the self-assessment levels is presented in Appendix 2.

Students also provide a list of relevant experiences through which they have acquired each Level 2 skill. These relevant skill building experiences may have come from a particular IS course, from an internship, from extra curriculum activities or from any other business, social science or arts course taken across the university or even while on exchange at another university overseas. From the student's perspective, what is being evaluated in his or her own "total capability" with respect to the SIS learning outcomes for the undergraduate program, without restriction as to whether part or all of that capability is the result of IS course or school-specific (versus university-level) experience. A sample screen shot of a student's self-assessment is provided in Figure 5.

At the start of the 2007-08 academic year, LOMS was deployed and students were requested to start the practice of completing their self-assessment at the end of each semester. Each end-of-semester assessment is stored in LOMS. This self-assessment exercise is intended to stimulate students to critically think and analyze what they have learnt, what their current skills are, and what they are able to do. These assessments are also intended to encourage students to take responsibility for their own learning within and beyond the classroom.

Progress Report Feature

LOMS also allows students to retrieve their past assessments, and provides a visual representation of their ongoing progress. A sample of the format of such a report is shown in Figure 6.

For each Level 2 skill, this reporting feature enables students to see and analyze their ongoing progress over their four years of studies. If the skill is undeveloped or only slightly developed, and there is no progression, the student is clearly aware of this limitation and may either choose to do something to develop this skill or choose to acknowledge that they are not in a position to pursue employment opportunities that require strength in this skill at the very beginning of a job assignment. To plan how to improve a skill, LOMS provides an option for students to create a self-development plan, which is discussed in the next section.

A point raised in several design and user testing sessions is that some students might overstate their skill attainment level, and release the inflated self-assessment information to potential employers. SIS is choosing not to "police" the students' self-assessment. We prefer to let "market forces" and peer interactions moderate or regulate a student's degree of truthfulness. After all, if a student overstates his or her attainment level on a particular skill and an employer asks about this capability either in an interview or later on when the person has difficulties performing that skill on the job, the student must deal with the consequences of exaggeration or overstatement. In this sense, the LOMS self-assessment process is no different than the process of preparing and using a resume. The person who prepares the resume is held accountable for the contents.

Self-Development Plan Feature

A student skill-development plan for capability improvement is designed for Level 1 learning outcomes only. Students are able to select any one of the eight Level 1 learning outcomes to develop an improvement plan with respect to it. The decision to provide the self-development plan at Level 1 only was based on student feedback acquired through multiple rounds of user testing held prior to deployment.

The system provides guidance (what, why, when, how) to the student to help him or her to create a plan with enough specificity and substance to be meaningful and achievable. A sample student development plan is presented in Figure 7.

The development plan feature is meant to encourage students to take responsibility for their own skills development. In addition, if they succeed in achieving their plan, it also develops their learning to learn skills.

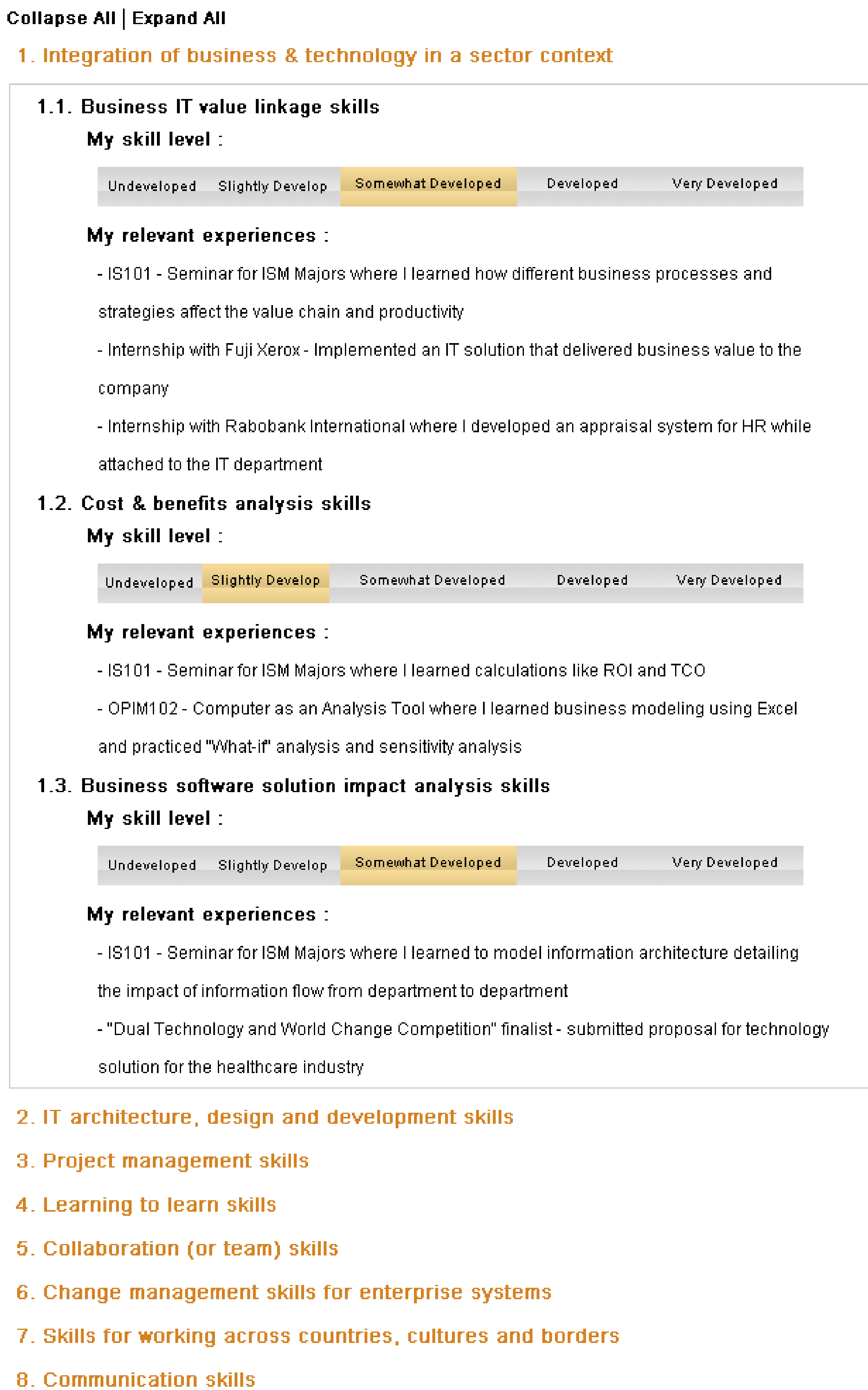


Figure 5. Sample of the LOMS Student Self-Assessment

Academic Year	2003-04	2003-04	2003-04	2004-05	2004-05	2004-05	2005-06	2005-06	2005-06	2006-07	2006-07	2006-07
Term	T 1	T 2	T 3	T 1	T 2	T 3	T 1	T 2	T 3	T 1	T 2	T 3
1. Integration of business & technology in a sector context												
1.1. Business IT value linkage skills												
Very Developed												
Developed										●	●	
Somewhat Developed			●	●	●	●	●	●	●			
Slightly Developed		●										
Undeveloped	●											
1.2. Cost & benefits analysis skills												
Very Developed											●	
Developed									●	●		
Somewhat Developed			●	●	●	●	●	●				
Slightly Developed		●										
Undeveloped	●											
1.3. Business software solution impact analysis skills												
Very Developed												
Developed									●	●	●	
Somewhat Developed							●	●				
Slightly Developed			●	●	●	●						
Undeveloped	●	●										
2. IT architecture, design and development skills												
2.1. System requirements specification skills												
Very Developed												
Developed										●	●	
Somewhat Developed				●	●	●	●	●	●			
Slightly Developed		●	●									
Undeveloped	●											

Figure 6. Sample the LOMS Student Progress Report

Release to Employer Feature

LOMS gives a student the choice of whether or not to release his or her learning outcomes self-assessment to the university's career services office. This voluntary release allows career services to provide a student's self-assessment report to potential employers (internship or future employer), together with the student's resume. LOMS is integrated with the SMU Career Services OnTRAC system which interfaces with employers. Through this integration, a student's self-assessment report can be viewed by the employer. A sample presentation of a student's resume and LOMS self-assessment that can be viewed by an employer via OnTrac, is shown in Figure 8.

During the design phase of the LOMS student interface, the issue of whether or not an SIS undergraduate student's learning outcomes self-assessment should be presented to employers was a topic of considerable debate. There are several reasons for advocating that this information should be shared with employers. The first reason is that it enables each student to present themselves in terms of their particular skills, experiences, and choices made as to which type of skills development they have chosen to emphasize. For example, some students might have chosen to put extra emphasis on the development of their project management skills whereas others might have chosen to undertake special experiences to strengthen their IT architecture, design and development skills. This is in contrast to presenting themselves primarily in terms of cumulative grade point average and courses completed.

The LOMS assessment provides information which is complementary to and supportive of the information in the student's resume. LOMS provides the IS students with a good structure to talk about things they have done to build the skills they have chosen to emphasize. These stories related to skills and skill-building provide a more engaging way to communicate with potential employers. It also puts more emphasis on a student's portfolio of capabilities and experiences, and less emphasis on cumulative GPA.

A second important reason is that if employers think the concept of the SIS learning outcomes is a good idea, and they begin to talk to SIS students in terms that reflect the learning outcomes, students will quickly communicate to one another that employers take the SIS learning outcomes framework seriously.

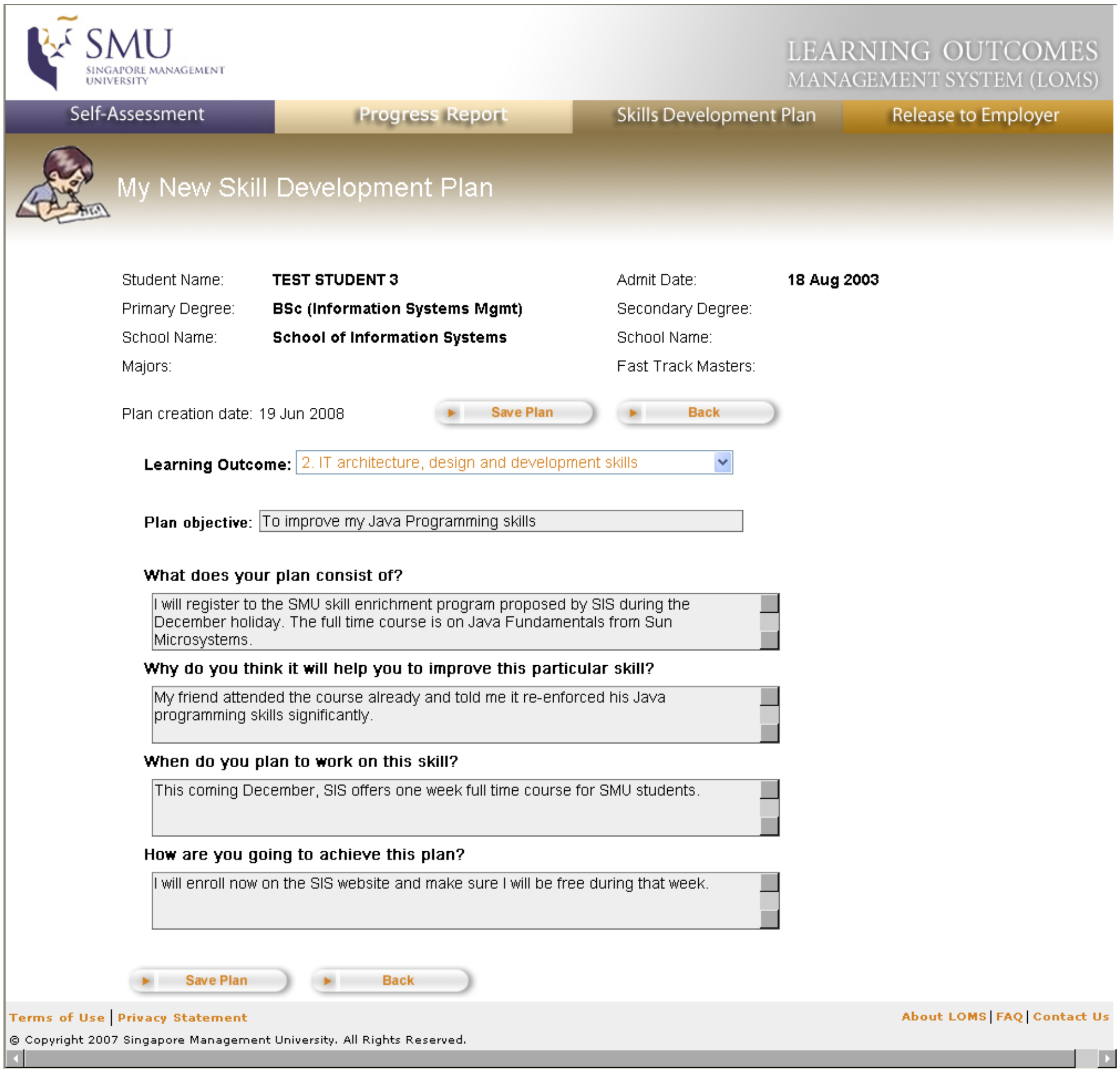


Figure 7. Sample the LOMS Student Self-Development Plan

Of course, there are also valid reasons for not sharing this information with employers. One reason frequently cited is the concern for privacy. In response to this concern, we have made the choice of whether or not to release the information to employers a voluntary decision for the student.

Whether or not a student chooses to release his or her LOMS self-assessment information to employers, we feel it is very important for each student to go through the self-assessment exercise at the end of each term. In their own private time and space, they reflect on how they are doing with respect to each of the Level 2 skills. Even if they shade the truth to some degree when they answer each assessment question, they have to go through the experience of self-reflection as to where they stand. Our experience is that due to the large number of team projects and peer-to-peer interactions that are part of the SIS learning experience, each student has a very clear sense of where they stand with respect to their peers on any skill or subskill in the learning outcomes. Hence, if they choose to overstate the degree of skill attainment on a particular skill, we believe they are still aware of the “real” situation. Ultimately, their self-awareness brought about through this ongoing process of self-assessment is what is most important to us.

Integrated Conceptual View of the SIS Learning Outcomes Framework and LOMS

An integrated view our learning outcomes framework, including the learning outcomes definitions, LOMS, and interfaces with faculty, students, and external employers is shown in Figure 9. Our learning outcomes master definitions, created by SIS faculty, with guidance from Carnegie Mellon faculty and with inputs from industry advisors, constitutes the basis for LOMS used by faculty and students. Faculty use the course-specific learning outcomes summary table as part of the process of course creation and revision. A program-level overview of learning outcomes is automatically generated within the faculty application as a byproduct of course specific information.

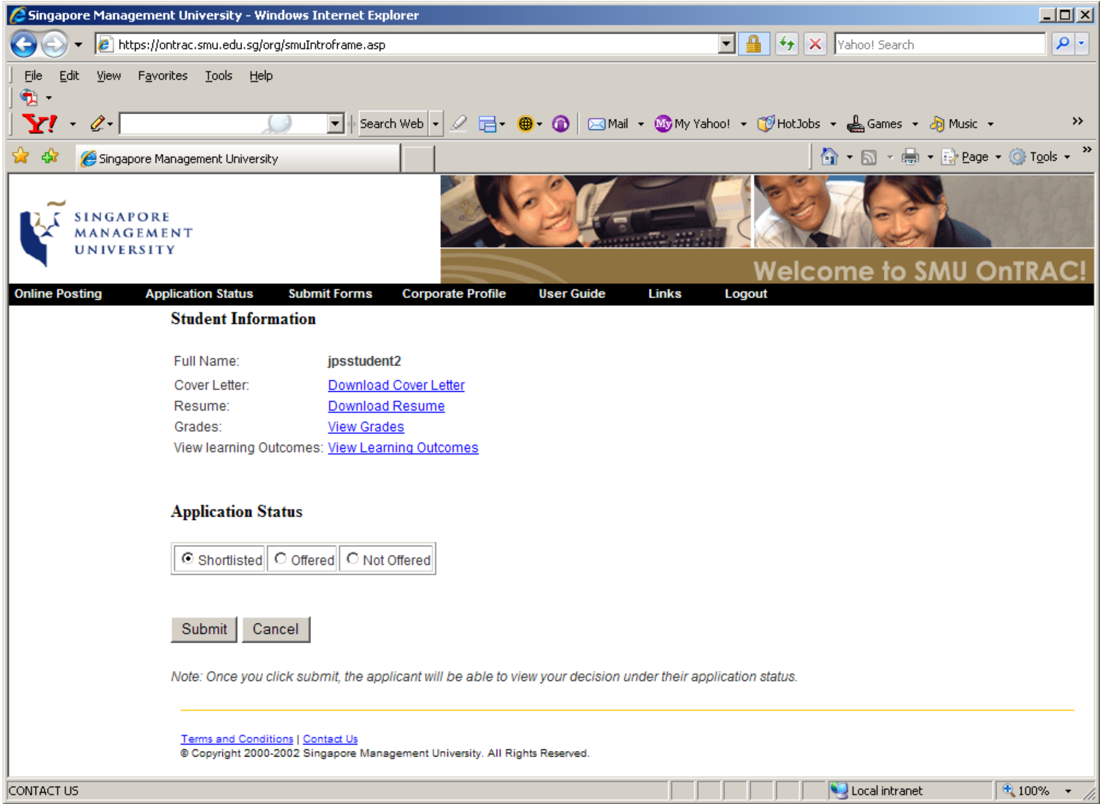


Figure 8. Student Information Seen by Employers on OnTrac

When authorized by a student, his or her self-assessment report can be accessed by employers via the Office of Career Services OnTrac system. Employers provide both formal and informal feedback to SMU Career Services and directly to the School of Information Systems per how students are performing relative to the school's stated learning outcomes. This all supports continuous process improvement.

VIII. CONCLUSION

This paper presents how the School of Information Systems of the Singapore Management University defined and refined a set of learning outcomes for its IS Bachelors program. Our learning outcomes framework supports curriculum design and redesign, student self-assessment, and communication with industry employers. It has taken six years to go from a first draft of high-level learning outcomes for a brand new IS bachelors program to the point where we have a comprehensive and nearly stable learning outcomes framework. A supporting IS application, the Learning Outcomes Management System (LOMS), has been developed and implemented to support the needs of faculty, students and employers to make practical use of learning outcomes.

Our learning outcomes framework, including the supporting LOMS software application, goes beyond any other reported effort in terms of integrating learning outcomes into program-wide and course-specific curriculum development, ongoing curriculum redesign, and into student learning support. The Learning Outcomes Management System (LOMS) described here is a first-of-a-kind information system created to support the implementation of this learning outcomes initiative.

LOMS enables faculty to explicitly specify and share their course-specific learning outcomes, and enables the dean's office to see the big picture of learning outcomes coverage across all IS courses comprising the program. This information can be viewed at the most detailed Level 3 description of subskills or at more aggregated Level 2 description of skills. LOMS also enables faculty to see how their particular courses fit in with the rest of the SIS program. This integrated view benefits our School of Information Systems, as it highlights the extent to which our desired learning outcomes are actually being incorporated into the various parts of the SIS core curriculum, and makes it easier to detect gaps in coverage. This guides SIS in the continual improvement and redesign of the curriculum.

From the student point of view, LOMS allows each student to manage his or her learning outcomes' self-assessment throughout the duration of undergraduate studies. The student self-assessment is designed with the intent of encouraging students to also engage in learning for the purpose of skills development rather than solely taking

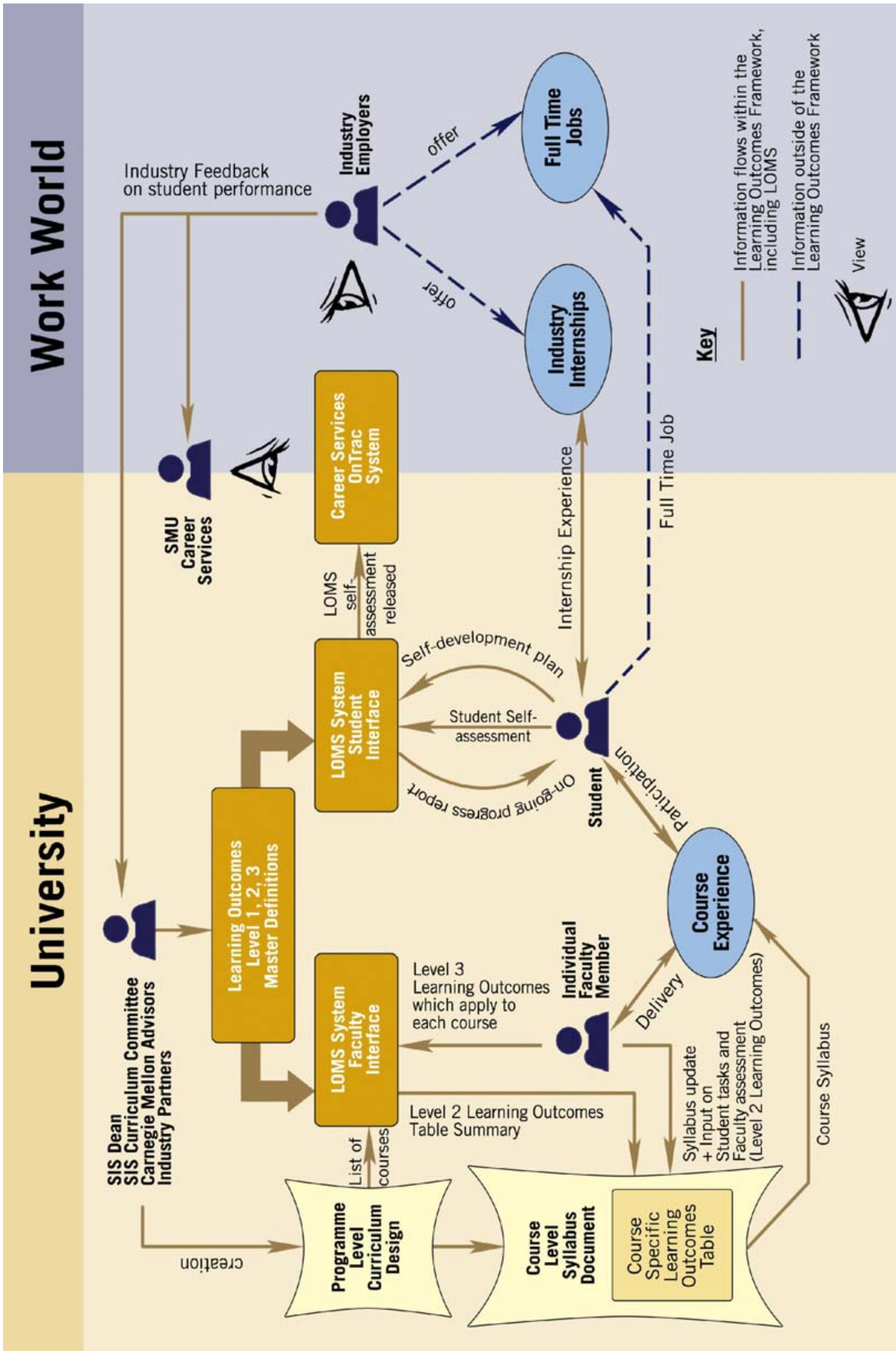


Figure 9. Integrated Conceptual View of SIS LOMS

courses for the purpose of managing and maximizing their cumulative GPA. The learning outcomes self-assessment process also gives each student a clearer sense of his or her own skill profiles and interest. Finally the LOMS benefits students by giving them more innovative and powerful way to communicate their skills set, skill-development experiences and interest to potential employers.

In August, 2007, we focused on LOMS adoption and usage across the entire first year student cohort. A group of 25 first- and second-year student "LOMS Champions," supported by school faculty, spearheaded the effort to get all

210 first-year students to do their self-assessments. Eighty-five percent of the first-year cohort actually followed through and did the assessments. LOMS is being used by some of the current second-, third- and fourth-year students as well, but at a lower rate of participation. Our implementation strategy is to keep focusing on building strong LOMS awareness, acceptance and usage for all cohorts that enter the school from 2007 onward. At the same time, we still continue to encourage LOMS usage for students who entered prior to 2007.

Given undergraduate student attentiveness to potential employers and jobs after graduation, we have been working closely with the university's office of career services to jointly promote and emphasize the importance of LOMS. Working through career services, we are in the process of systematically communicating with every firm that has employed any of our students as interns since the school's inception in 2003 (340 companies) to make them aware of our learning outcomes framework. We are specifically requesting that whenever the firm interviews one of our School of Information Systems students, they ask to see his or her learning outcomes self-assessment report. Our students have repeatedly told us that the most compelling way to motivate them to do their self-assessments on a regular basis is to demonstrate that employers are keenly interested in our learning outcomes and the related student self-assessments.

As of 2008, we are transitioning from the design, trial and initial school-wide deployment phases of LOMS to the ongoing utilization, refinement, wide-spread acceptance, and sustainability phases. The six-year journey leading up to the school-wide deployment of LOMS has been a powerful educational experience for all stakeholders. Yet, it is apparent that we have only progressed a short way toward the goal of full acceptance and high rates of utilization across School of Information Systems faculty and students. We believe that in order to sustain and improve acceptance and utilization, the dean's office must continue to drive ongoing "waves" of implementation effort to:

1. Follow up in detailed ways to verify how and to what extent the overall learning outcomes framework is actually being used by faculty and students.
2. Make process and technology changes that facilitate ease of use.
3. Work with the university's career service office to motivate employers to always ask our students for their learning outcomes self-assessments during interviews, and thereby demonstrate to students that it is in their self-interest to regularly do their self-assessments.
4. Keep demonstrating to faculty that the school is firmly committed to anchoring its educational programs to a learning outcomes framework, and that it is, in fact, an nonnegotiable "job requirement" to make use of this framework.

We estimate that another three to five years of efforts are required to deeply ingrain the learning outcomes framework into the school's culture and behavior to the point where it becomes self-sustaining.

ACKNOWLEDGEMENTS

We gratefully acknowledge the faculty and instructors of the SMU School of Information Systems for their willingness to actually use the school's learning outcomes in the design of their courses and in their course syllabus documentation. This initiative would not have progressed without their feedback and suggestions over the past four years.

We also acknowledge the extensive contributions of the core team of Carnegie Mellon faculty members who were active participants in the design, launch and refinement of the SIS undergraduate curriculum, including the learning objectives. The Carnegie Mellon core team consisted of Professor Paul Goodman (Tepper School), Professor Ramayya Krishnan (Heinz School), Professor Tridas Mukhopadhyay (Tepper School) and Professor Eric Nyberg (Computer Science and Heinz School).

We owe a very special acknowledgement to Professor Vanessa Chang from Curtin University, Perth, Australia. During a three-week visit to the SMU School of Information Systems in 2006, Vanessa urged us to write a paper on our experience with our learning outcomes initiative. Vanessa was familiar with relevant references, and graciously shared this information with us. She also provided extensive advice, guidance and editing support for earlier versions of this paper.

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Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that:
1. These links existed as of the date of publication but are not guaranteed to be working thereafter.
2. The contents of Web pages may change over time. Where version information is provided in the references, different versions may not contain the information or the conclusions referenced.
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APPENDIX 1: COMPLETE SET OF SIS LEARNING OUTCOMES

Version of 2008, May 28th

Level 1	**1**	**Integration of business & technology in a sector context**
Level 2		**1.1 Business IT value linkage skills**
		Ability to understand & analyze the **linkages** between:
Level 3		a) Business strategy and business value creation
		b) Business strategy and information strategy
		c) Information strategy and technology strategy
		d) Business strategy and business processes
		e) Business processes or information strategy or technology strategy and IT solutions
		1.2 Cost & benefits analysis skills
		Ability to understand and analyze:
		a) Costs and benefits analysis of the project
		1.3 Business software solution impact analysis skills
		Ability to understand and analyze:
		a) How business software applications impact the enterprise within a particular industry sector
	2	**IT architecture, design and development skills**
		2.1 System requirements specification skills
		Ability to:
		a) Elicit and understand functional requirements from customer
		b) Identify nonfunctional requirements (performance, availability, reliability, security, usability etc.)
		c) Analyze and document business processes
		2.2 Software and IT architecture analysis and design skills
		Ability to:
		a) Analyze functional and nonfunctional requirements to produce a system architecture that meets those requirements.
		b) Understand and apply process and methodology in building the application
		c) Create design models using known design principles (e.g. layering) and from various view points (logical, physical etc.)
		d) Explain and justify all the design choices and trade-offs done during the application's development
		2.3 Implementation skills
		Ability to:
		a) Realize coding from design and vice versa
		b) Learn / practice one programming language
		c) Integrate different applications (developed application, cots software, legacy application etc.)
		d) Use tools for testing, integration and deployment

	2.4 Technology application skills
	Ability to:
	a) Understand, select and use appropriate technology building blocks, components and packages when developing an enterprise solution (e.g. integration middleware, portal, ERP, CRM, SCM and other enterprise solutions)
3	**Project management skills**
	3.1 Scope management skills
	Ability to:
	a) Identify and manage trade-offs on scope/cost/quality/time
	b) Document and manage changing requirements
	3.2 Risks management skills
	Ability to:
	a) Identify, prioritize, mitigate and document project's risks
	b) Constantly monitor projects risks as part of project monitoring
	3.3 Project integration and time management skills
	Ability to:
	a) Establish WBS, time & effort estimates, resource allocation, scheduling etc.
	b) Practice in planning using methods and tools (Microsoft project, Gantt chart etc.)
	c) Develop/execute a project plan and maintain it
	3.4 Configuration management skills
	Ability to:
	a) Understand concepts of configuration management and change control
	3.5 Quality management skills
	Ability to:
	a) Understand the concepts of quality assurance and quality control (Test plan, test cases etc.)
4	**Learning to learn skills**
	4.1 Search skills
	Ability to:
	a) Search for information efficiently and effectively
	4.2 Skills for developing a methodology for learning
	Ability to:
	a) Develop learning heuristics in order to acquire new knowledge skills (focus on HOW to learn versus WHAT to learn)
	b) Abide by appropriate legal, professional and ethical practices for using and citing the intellectual property of others
5	**Collaboration (or team) skills:**
	5.1 Skills to improve the effectiveness of group processes and work products
	Ability to develop:
	a) Leadership skills
	b) Communication skills
	c) Consensus and conflict resolution skills
6	**Change management skills for enterprise systems**
	6.1 Skills to diagnose business changes

	Ability to:
	a) Understand the organizational problem or need for change (e.g. Analyze existing business processes or "as-is process")
	6.2 Skills to implement and sustain business changes
	Ability to:
	a) Implement the change (e.g. Advertise/communicate the need for change etc.) and to sustain the change over time
7	**Skills for working across countries, cultures, and borders**
	7.1 Cross-national awareness skills
	Ability to:
	a) Develop cross-national understandings of culture, institutions (e.g. law), language etc.
	7.2 Business across countries facilitation skills
	Ability to:
	a) Communicate across countries
	b) Adapt negotiation and conflict resolution techniques to a multicultural environment
8	**Communication skills**
	8.1 Presentation skills
	Ability to:
	a) Provide an effective and efficient presentation on a specified topic.
	8.2 Writing skills
	Ability to:
	a) Provide documentation understandable by users (requirements specification, risks management plan, assumptions, constraints, architecture choices, design choices, etc.)

APPENDIX 2: DESCRIPTION OF SELF-ASSESSMENT LEVELS

Levels	Description of the Levels
Undeveloped	• Have not been exposed to subject
Slightly Developed	• Have been exposed to and understand basic concepts • Initial experience through class exercises, labs and course projects • Able to complete small course projects with guidance
Somewhat Developed	• Have been exposed to and understand intermediate concepts • Able to complete small to medium projects in course setting or industry internships with minimal guidance
Developed	• Have been exposed to and understand advanced concepts • Able to complete medium to large projects in course setting or industry internships with minor supervision • Have demonstrated the ability to learn how to learn
Very Developed	• Strong understanding of advanced concepts • Solid experience in subject through internships or professional exposure • Able to lead and advise teams or projects in this area

APPENDIX 3: IS 2002 INFORMATION SYSTEM CURRICULUM MODEL

This appendix shows a general and widely used model for an Information Systems Curriculum developed by key international professional associations to provide a context for those readers in the information systems (IS) field as well as those who come from disciplinary areas outside of IS. An IS undergraduate curriculum model known as the IS 2002 was jointly developed by the Association of Computing Machinery (ACM), the Association for Information Systems (AIS), and the Association of Information Technology Professionals (AITP). This model provides a common reference structure for a university-level IS degree program [Gorgone et al. 2002].

The model consists of the five core areas shown in Figure 10: (1) Business Fundamentals; (2) Technology; (3) Analytical and Critical Thinking; (4) Interpersonal Communications and Team Skills; and (5) Technology-Enabled Business Solutions Development. The purpose of this common reference structure for an IS undergraduate degree program is to convey the expectation both to employers and to students that a student who completes such a program has understanding of and competence in all five of these areas.

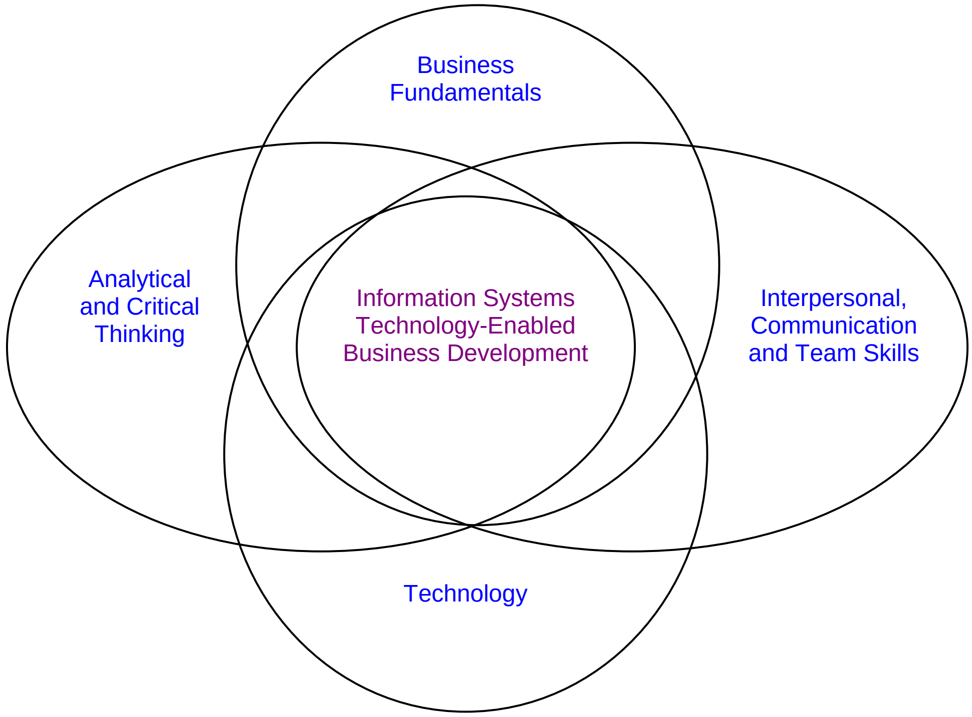
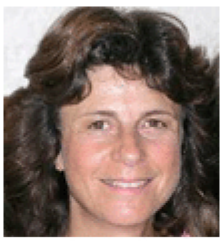


Figure 10. Common Reference Structure for an IS Undergraduate Program [Gorgone et al. 2002]

ABOUT THE AUTHORS



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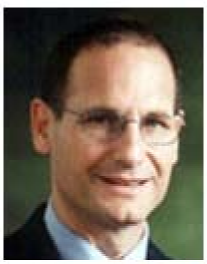

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